Article

The Biophysics at Death: Three Hypotheses With Potential Application to Paranormal Phenomena

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Abstract

Major explanations for the potential physical changes at death are explored quantitatively. MacDougall's weight loss measurements of dying patients are examined as an artifact of respiratory burst phenomena and as a potential variant of entanglement. The death flash, when considered as an integrated conversion of membrane potentials into biophoton emissions with intensities above the threshold for detection, is quantitatively compatible with biophysical mechanisms. The modulation of the optimal conditions that produce visibility by local geomagnetic intensities and man-made objects that distort these fields could explain the low frequency incidence of these observations. The release of fields of photons at death even below the threshold for visible detection and in the order of 10^{-11} to 10^{-13} W/m^2 may maintain information that has the potential to be represented in space-time (hyperspace).

Key Words: clinical death, energy release, weight changes, entanglement, quantitative solutions, geomagnetic field

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Introduction

Clinical death is the termination of the boundary conditions that define human life. Although the bioethical and philosophical implications of the consequences of this termination have profound significance (e.g., for medical treatments and personal meaning), there has been little exploration of the biophysics of death. Except for the establishment of conclusive diagnostic criteria (Evans, 1963), there are few published studies to describe what might be important concomitant phenomena. One interesting such phenomenon is transient photic emissions within the visible spectrum during death, which have occasionally been reported (Slawinski, 1987; Popp, 1988). It is unclear if the apparently infrequent published number of such reports is due to the complexity of variables that must convergence to generate such emissions or to a reluctance to report such anomalous phenomena. A second interesting phenomenon is the evidence of a discrete but sudden loss of weight at clinical death, reported by MacDougall (1907) in what has been an often cited study, despite the paucity of successful replication attempts. In

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this chapter, possible interpretations for the enigma of ostensible weight loss and light emissions that have been reported at clinical death are proposed.

The MacDougall Weight Loss at Death Findings

In 1907, Duncan MacDougall reported sudden weight losses for five dying patients. Four were terminal from tuberculosis while the fifth had been diagnosed with diabetic coma. The weight loss at the time of death, as inferred by audible stroke of the weighing beam, was 0.75 ounce (oz), 0.5 oz, 0.5 oz, 0.5 oz, and 0.4 oz. Within a few minutes after death another 10 oz was lost in two of the patients. The mean loss was 0.61 oz while the median loss was 0.5 oz. With 28 gm=1 oz, this median value is about 14 gm (range: 11 gm to 21 gm).

The Respiratory Burst Model

The four patients in the MacDougall study who were diagnosed with tuberculosis in all probability also had serious bacterial infections. Given the insidious emaciation of diabetes at that time the probability is high the diabetic patient would have also been compromised by bacterial infection. All five patients would have been prone to the respiratory burst (Alberts *et al.,* 2002) whereby resident phagocyte (macrophages and neutrophils) would assemble NADPH oxide that catalyzes O_2^-, HOCl, H_2O_2, OH^- and NO after a transient increase in oxygen. The sudden weight loss observed by MacDougall could have therefore simply been the result of the sudden release in CO_2. The equation $C_6H_{12}O_6 + 6O_2$ yields $6H_2O + 6CO_2 + 2.9 \times 10^9$ J of energy. One mole of CO_2=44 gm and one mole of gas at STP occupies 22.4 L. Consequently to lose 14 gm would require a release of 7 L of CO_2 gas.

The human lung capacity is certainly within this range. Typical values for total lung capacity=5.8 L. The vital capacity, which is the sum of the inspiratory reserve volume, the tidal volume, and the expiratory reserve, is about 4.6 L while the functional capacity, the sum of the expiratory reserve plus the residual volume, is about 2.3 L (Guyton, 1971). The inspiratory volume, which is the extra air that can be inspired above the tidal volume, is about 3 L. Hence a burst of CO_2 release into the surrounding environment from this biochemical event, with or without an observable expiration, would be within a fixed range of 10 g to 20 because of the relatively fixed volume of the average human lung.

These calculations suggest that the weight loss observed by MacDougall (1907) might have simply been artefacts of sudden release in gases from terminal chemical reactions associated with the specific diseases. Such conditions would be less likely today because of the routine administration of antibiotics. Considering the range in sudden weight loss, a more parsimonious interpretation of the phenomena might be they did *not* reflect the release of a singular fixed quantity, but rather the limited range of the volume of the lungs of the patients.

An "Entanglement" Model

In contrast, it could be that more was going on than this simple explanation. The ontogenetic biological system, such as a human being, is composed of two or more states, such that new states share some of the properties of each of the combined states. The superposition of two product states produces what has been called “entanglement” (Aczel, 2002). The description of biological systems as quantum phenomena (Bohr, 1958) allows application of concepts such as Hilbert space (Prosen, 1994) and the Higgs field (Halpern, 2006) to generate alternative interpretations of the equivalent between mass and energy and between particles and waves (de Broglie, 1962).

The approximately 20 gm of sudden weight change at death, associated with the massive depolarization across most cellular membranes, would be a mass equivalent of the biological energy if the former represented the latter's integration over the person's life time. Circular motions of particles around a center are unique in that they are technically always accelerating. This allows access to the Higgs field (Halpern, 2006) and other quantum processes involving entanglement. The most fundamental particle/wave with this property is the electron.

For the electron, this velocity is obtained by setting Coulomb's law $F=(1/4 \pi e_o)(e^2/r^2)$ where e_o, the permittivity constant, is 8.9×10^{-12} $coul^2/N\text{-}m^2$ and r is the Bohr radius of 5.1×10^{-11} m, equal to Newton's second law of $F=(mv^2)/r$ where v=velocity and

m is the mass of the electron, 9.1 x 10^{-31} kg). The solution for the orbital velocity is the square root of $e^2/(4pi\ e_o\ m\ r^3)$ or 2.19 x 10^6 m/s. This value, which is 1/137 less than the speed of light is the so-called "fine structure" velocity.

The energy equivalence would be $J= 1/2(mv^2)$. If we assume the equivalent heat production (Cameron, Skofronick, & Grant, 1962) with a weighted average of 50 J/s or Watts throughout a lifetime, then a person who lives to be 65 years or about 2 Gigaseconds (2 x 10^9 s) of age would have entangled 0.5 and 10^{11} J of energy. The mass equivalent would be $m=2J/v^2$ or [1 x 10^{11} J/4.8 x 10^{12} m^2/s^2] or 21 x 10^{-2} kg (21 g). This is well within the range of 11 gm to 21 gm recorded in MacDougall's experiments.

It may be relevant that the role of less-than-light velocities of electrons have been implicated in biological matter. Cosic (1994) showed that a protein's biological activity is most strongly correlated with parameters that are related to the energy of delocalized electrons of each composite amino acid. The velocity of these electrons, from her calculations, would be < 7.87 x 10^5 m/s or about 3.14 less than then the value for the fine structure velocity of 1/137 c. However the energy equivalence of a 20 gm loss for this velocity would require the lifetime entanglement from a source within an average of about 10 J/s, which is within the range of human brain. This provides a plausible alternative explanation to what might have been observed by MacDougall (1907).

Light Emission at Death: The "Death Flash"

When hospitals were darker or employed the altered frequency spectra from gas light or candles as their primary source of luminescence, there were occasional reports of "bluish" or "whitish" lights, estimated to be about 10 cm in diameter that transiently hovered over the dying person's chest (Miller, 1947). Emissions within the bluer wavelengths are associated with changes in oxidative states (Van Wijk, 1988).

How much energy would be required to detect any light emission from the dying person? The quantity of light for the dark-adapted eye to see a flash is 5 x 10^{-17} J (Woodsworth and Scholsberg, 1962). Hecht (1944) found the minimum required for an effective flash was about 51 to 148 quanta. Half the quanta are lost through the lens, cornea and humours. While about 26 to 70 reach the rods and cones, 80% pass between these sensors and are absorbed by black pigment in the scleroid coat. Spatial summation is complete over about 500 rods. One quantum is required to stimulate one rod but the reaction from approximately 5 to 14 rods must summate for the threshold.

Assuming 100 as a median value for numbers of quanta, then this would be 5 x 10^{-19} J/quanta. The energy changes with wavelength according to J=h (Planck's constant) multiplied by the frequency of the electromagnetic wave. These energies for different wavelengths (perceived colors) would be 4.3 x 10^{-19} J for blue (450 nm; 0.67 x 10^{15} Hz) light and 3.1 x 10^{-19} J for red (720 nm; 0.41 x 10^{15} Hz). At the threshold for discerning light (around 400 nm), the energy would be 5 x 10^{-19} J.

According to Popp (1979), approximately 100 photons/cm^2 or 10^6 photons/m^2 within the visible range are emitted per sec from the human surface area. A million photons with an average energy of 5 x 10^{-19} J would be 5 x 10^{-13} J, which is well within the detection level of the human eye even correcting for the fact that the perceptual perspective of the observer would be exposed to between one-quarter to one-half the whole body emission.

At a distance of 1 m from the person, the shell of photons would have a surface area ($4pi\ r^2$) of 1.256 x 10^1 m^2 while the area of the fovea, assuming r=0.5 mm, would be ($pi\ r^2$)=.78 x 10^{-6} m^2. The proportional area would be this area divided by the total area or .62 x 10^{-7}. If this value is multiplied by the total output of 5 x 10^{-13} J, the energy impinging upon the fovea would be 3.1 x 10^{-20} J.

This value is within measurement error of the same energy exerted by the net change in an action potential (120 mV or 1.2 x 10^{-1} V) on a unit charge of 1.6 x 10^{-19} coulombs and would be at the threshold for the stimulation of a single photosensor. However the energy would be below the threshold for the detection of a flash by a factor of 100 unless the whole body energy emission was increased by a factor of 1000. This value is the estimated enhancement of the death flash.

Where the Light Would be Localized?

The coherent release of photons from only a small fraction of the 10^{12} 10^{13} cells of the body and particularly the approximately 10^{10} to 10^{12} cells within the brain would be required for light emission to be discerned by the observer. Even though each cell would generate photons the mass density of adjacent cells, analogous to the loss of photons moving through the eye, would attenuate their continued emissions.

Within the body the region with the least cell density would involve the lungs because of the large volume of air and the relatively thin layer of tissue within the area over the sternum. Casual observations have indicated that the anomalous glows are more likely to occur most intensely over the chest of the supine dying patient.

Although one would expect the brain's high density of cells to be a major source of light emission, the thickness of the calvarium would impede this process. When it occurs it would be diffuse and limited to a corona. Conditions, such as partial complex seizures, that promote synchronization of ion movements within large volumes of neurons, would be expected to promote more intense light emissions. Rare conditions such as partial complex status epilepticus continualis involving the temporal lobes might allow for low-level maintained emissions, perceived as "glows," for protracted periods.

Modulation by the Local Geomagnetic Field

The maintenance of the properties of the cellular membrane defines and permits the phenomena of life. However this liquid crystal state exists within a narrow range of biological parameters primarily determined by local pH, the relative content of water, and temperature. When death occurs and the processes required to maintain the separation of charges across membranes are lost, massive numbers of ion channels are opened that allow the potential differences across the membranes to be reduced to zero and for cells to die. The energy involved with the separation of approximately 10 nm between the charges around the membrane that create this potential difference is about 10^{-20} J.

If there are about 10^{7} ions per channel (Kandel, Schwartz, and Jessell, 2000) then 1.6 x 10^{-19} A s multiplied by this value results in 10^{-12} A s or about 1 pA/s (Park and Lee, 2007). The energy associated with this movement of charge can be described as J= (As) times kg/As^2 (magnetic field strength, B) times m^2, times 1/s (frequency) where m^2 is the area of channel opening (width=10^{-9} m). The frequency for this solution, by which wavelength of an emitted energy can be discerned, would be f=J/[(As) B m^2].

For 50,000 nT (5 x 10^{-5} T), an average value for the earth's resultant geomagnetic field strength, the frequency would be: 10^{-20} J/[10^{-12} As x (5 x 10^{-5} T) x 10^{-18} m^2] or 0.2 x 10^{15} Hz. Assuming the photons are moving at the speed of light 3 x 10^{8} m/s, then dividing by this frequency results in a wavelength of 1.5 x 10^{-6} m or 1500 nm. This is the near infrared range. If the background geomagnetic field was 1/5 its normal intensity, which can occur due to effects from nearby conductors such as bed springs, door frames or metallic equipment, then the frequency from the above equation would be 1 x 10^{15} Hz and the resulting wavelength would be [3 x 10^{8} m/s]/[1 x 10^{15} Hz] or 3 x 10^{-7} m or 300 nm. This is within the near-ultraviolet range.

Consequently, if this relationship is valid, then the modulation of the frequency within the visible range of the emitted energy from the sudden opening of cell membrane ion channels and the movement of these quanta of ions across the membrane would be modulated by subtle nuances in the intensity of the earth's static magnetic field. Even cursory empirical measurements by magnetometers show that iron or steel bed frames, medical monitoring equipment, and metallic desks can reduce the local static magnetic field across this same narrow range of intensities and would modulate the emission of energy within the visible range. This provides a plausible alternative explanation to what might have been observed as light emission at death, known as the death flash.

Conclusion

The biophysical processes that occur around death have significant medical, psychological and philosophical implications. Although the details of the chemistry of death have been investigated relatively thoroughly (Evans, 1963), there are still important questions regarding the consequences of death upon the

biological information that might be maintained as entangled energies within the matter composing the human being as a contained biological boundary. These data have been in large part ignored by arbitrary restriction upon our philosophical, psychological, and medical perspectives of post-death phenomena.

The existence of discrete losses of mass and light flashes would not necessarily suggest or prove the discrete existence or non-existence of identities unique to the person after death. Furthermore, the calculations in this paper do not support the validity of either assumption, though they do provide some plausible interpretations of mysterious phenomena that have been reported at the time of death. Classic quantitative solutions indicate that the MacDougall (1907) report of a sudden loss of about 20 gm of weight in five patients was most likely an artifact of respiratory burst activity due to bacterial infection. However if quantum mechanisms are applied, the mass equivalent of the entanglement of the total energy from glucose utilization over the person's lifetime would be within the range of 20 gm. Quantitative solutions also demonstrated the death flash associated with the release of biophotons is congruent with the near-simultaneous conversion of energy from the myriad ion channels within the cells of the body. The measurement of the visible range may be strongly modulated by the small alterations in intensity of the ambient geomagnetic field. Calculations suggest that some energy from every human being might be also stored within the earth's magnetic field. The results strongly suggest that the quantifiable changes at clinical death can be investigated and may lead to a more scientific consideration of possibilities that have been relegated traditionally to speculative or philosophical domains. For example, appropriate spectral analyses of emissions at death may yield revealing information concerning the medical status and history of the patient, as well as the conditions that might allow the representation of this energy within other spaces or geometries.

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